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Double-crested cormorants *(Phalacrocorax auritus)* are a common migrant in Arkansas in the fall and spring. In most years, many linger until freeze-up prior to moving south. In south Arkansas, they may overwinter if climactic conditions are not too severe. Although they were formally year-round residents, there are no current reports of substantial breeding flocks in the state. According to band returns, most cormorants found in Arkansas come from North and South Dakota, Wisconsin, Saskatchewan, or Manitoba (James and Neal 1986).

Previous investigations by Bivings et al. (1989) and Campo et al. (1988) reported that gizzard shad *(Dorosoma cepedianum)* comprised the bulk of the diet of migrant cormorants. The purpose of this study was to further examine the impact of cormorants at Arkansas aquaculture facilities. I would like to thank N. Anderson, I. F. Anderson, D. Yocum, M. Freze, D. Nixon, H. Hammans, C. Summerhill, J. Wilkinson, B. Goetz, and the many others who assisted with this project. Thanks are also due to T. Booth, M. Hoy, and J. Jones for their encouragement and assistance.

STUDY AREA AND METHODS

The study was conducted from October 1988 through December 1989 in central and southeast Arkansas at various aquaculture facilities. Prior to collection, each facility was surveyed to determine the number of birds present and their location. Most cormorants were collected with shotguns, although a few were taken with rifles. Birds were taken either at the feeding site or in transit to or from roosting or loafing sites. Collection of downed birds was simplified by use of trained retrieving dogs.

Cormorant esophagus and stomach contents were removed and prey items taxonomically identified. Fish prey consumed were classified to either genus or species. Prey were counted by species for each bird and tabulated. The Chi-square distribution was used to test for differences in percent shad in the diet between samples (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Fifty-eight cormorants were collected in the spring of 1989. Of the 44 with identifiable prey in them, all had consumed only cultured fish (Table 1). This sample was significantly ($P < 0.001$) different from the previously reported sample (Bivings et al. 1989). Because of this dramatic change in diet, another sample of 30 cormorants was collected in the fall of 1989 to replicate collections at 2 sites sampled in the fall of 1988 (Table 2). Because of changes in sampling intensity, no comparisons of pooled

data were appropriate. Although sample sizes were different, it appeared that variation in percent consumption of cultured fish, compared to rough fish, between 1988 and 1989 at the Nixon farm (Table 3) was minimal. Abundance of shad in the diet at the Hammans farm (Table 4) was not significantly different between years. Abundance of shad in the diet at the Nixon farm in 1989 was significantly ($P < 0.001$) different from the 1989 Hammans farm sample.

Table 1. Occurrence of prey species in esophagus/stomach of double-crested cormorants in April-May 1989 in Arkansas.

Prey Species	No. of Birds	% of total
Golden shiners	10	22.2
Channel catfish	33	73.3
Fathead minnow	1	02.2
Unidentified	1	02.2
		99.9

Table 2. Occurrence of prey species in esophagus/stomach of double-crested cormorants in October-December 1989 in Arkansas.

Prey Species	No. of Birds	% of total
Shad	12	44.4
Channel catfish	4	14.8
Koi	1	03.7
Golden Shiner	7	25.9
Grass carp	4	14.8
Sunfish (*Lepomis* sp.)	2	07.4
		111.0

Table 3. Occurrence of prey species in esophagus/stomach of double-crested cormorants in October-December 1989 at Nixon Farm, Lonoke, AR.

	1988		1989	
Prey species	# birds	%of total	# birds	%of total
Shad	0	00.0	1	07.1
Koi/ goldfish	2	67.7	1	07.1
Channel catfish	0	00.0	2	14.3
Golden shiner	0	00.0	6	42.9
Grass carp	1	33.3	4	28.6

Table 4. Occurrence of prey species in esophagus/stomach of double-crested cormorants in October-December 1989 at Hammans Farm, Humphrey, AR.

	1988		1989	
Prey species	# birds	%of total	# birds	%of total
Shad	78	82.1	12	66.7
Golden shiner	4	04.2	1	05.6
Channel catfish	8	08.4	3	16.6
Sunfish	5	05.3	2	11.1

Sampling in the fall of 1988 and spring of 1989 was conducted primarily at locations where cormorants were abundant. The small sample size at the Nixon farm in 1988 reflected the low abundance of cormorants at this site. Collection sites were usually selected because of the abundance of cormorants. Most sites that had abundant cormo-

rants in the fall had few cormorants in the spring and vice versa. Casual observations indicate that the quantity and/or ease of harvest of the fishery resources available to the birds are the dominant factors in selection of feeding sites.

In summary, cormorants seem to feed opportunistically to harvest the fish resource that is most readily available at the time. In this study, cormorants congregated in the fall in areas where shad were abundant, possibly to benefit from lethargic shad behavior caused by falling water temperatures (Carlander 1969). Subsequent collections in the spring revealed a significant change in that all birds sampled had fed exclusively (100%) on aquaculture fish. In the spring, fish farms probably represent the best concentration of fish available to the birds. Because of the demonstrated ability to consume high value fish such as koi and grass carp, even relatively small flocks of cormorants can cause significant economic damage.

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